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UNITED STATES DEPARTMENT OF AGRICULTURE

CANKER STAIN OF PLANETREES

By James M. Walter,[1] formerly *pathologist, Division of Forest Pathology, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration* [2]

Contents

CANKER STAIN is a deadly disease of planetrees; it is caused by a fungus that is being spread by man, principally in his efforts to care for the host. The dissemination of the fungus by natural agencies is of little importance. In pruning, however, the fungus is very readily transmitted from tree to tree by procedures that have been considered good practice. It can be carried on pruning tools and in many of the commonly used brands of asphalt wound dressing. The most conscientious and best-informed commercial arborists and pruning crews doing line-clearance work for public-utilities companies unintentionally introduced the pest into many fine rows of planetrees before the means of spread of the disease were known.

Fortunately, research on the disease brought to light the basic information needed to develop practicable control measures. The effectiveness of the recommended control measures has been demonstrated where informed tree wardens, shade tree commissions, arborists, and others engaged in tree care have taken the simple precautions necessary to

[1] The author wishes to make special acknowledgment of information and aid without which the facts presented in this circular could not have been collected so quickly. These were freely given by each of the following because of his scientific interest in the problem and the concern of his organization for the welfare of its trees: J. C. Kenealy, tree warden of Lower Merion Township, Ardmore, Pa.; H. J. Howe, city forester, Baltimore, Md.; J. H. Walker, city forester, Newark, N. J.; Philip Alden, city forester, Kearny, N. J.; Edwin A. Rundlett, silviculturist, Borough of Richmond, New York City Department of Parks; E. G. Rex, supervisor, Plant Pest Control, New Jersey Department of Agriculture; and G. A. Wehrheim, superintendent of real estate, Worth Steel Co., Claymont, Del.

[2] Revised by Curtis May, principal pathologist, Division of Forest Pathology.

prevent spread of the disease. A municipality having an investment in planetrees in which it can take pride is entirely justified in requiring that every reasonable precaution be taken for the protection of these trees. In this circular the essential facts about this disease are presented; the precautions necessary to bring it under economic control are emphasized.

Importance

In the last half century London plane (*Platanus acerifolia* Willd.), the most severely affected species, has become one of the more important shade trees of the United States. In cities and towns, and in some localities even along the highways, of an eastern and central region including New York City, Pittsburgh, Washington, Roanoke, and St. Louis this tree has been planted by thousands. In addition, it has been planted in great numbers in cities along the west coast.

Experience has shown that it will thrive where scarcely any other tree except ailanthus will grow; because of its remarkable vigor and resistance to smoke, soot, and fumes, it is favored for use in industrial centers. Largely because of its uniformity, resistance to anthracnose, rapidity of growth, ease of transplanting, and availability, it has perhaps been used too extensively in the quick preparation of real estate developments. The popularity of London plane is indicated by the records of planting 153,000 in Philadelphia and 75,000 in Pittsburgh.

Canker stain was not recognized as a threat to London plane until 1933, when tree wardens and lovers of shade trees in the "Main-Line" district in the westerly suburbs of Philadelphia reported that their planetrees were dying in alarming numbers despite care by the best methods known to arborists. Studies of the disease, begun at that time by L. W. R. Jackson, formerly of the Division of Forest Pathology, soon disclosed the cause as a previously unknown fungus. The pest probably became established in some rows of planetrees in the Philadelphia district at least as early as 1925 or 1926.

The destructiveness of canker stain is shown by records of losses in one district of Gloucester, N. J., a town that is directly across the Delaware River from Philadelphia and that has one of the oldest known centers of the disease (fig. 1). The data, based on the number of trees originally planted in the selected district, show that, by 1943, 60 percent were a total loss and that an additional 12 percent were infected. The mortality rate was 5.6 percent a year between 1940 and 1943.

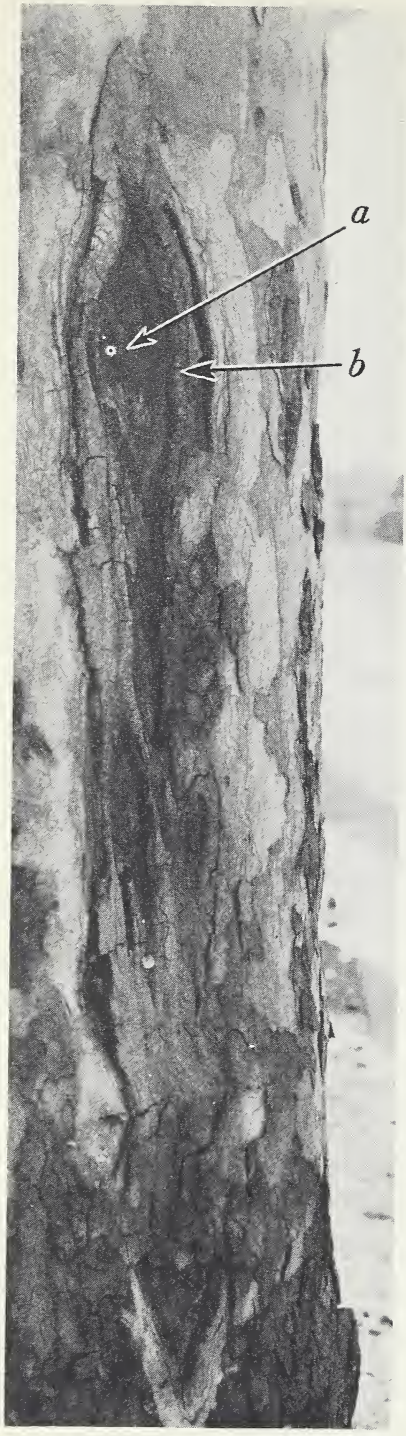
It is estimated that by 1946 10,000 of the 153,000 planetrees planted in Philadelphia had already succumbed to this disease. Losses of this nature are commonly evaluated by tree wardens and city foresters on the basis of the cost of removing the dead tree and planting a young one in its place. In 1940 this cost per tree in the Philadelphia district was about $35. The disease is more extensive there than in any other large metropolitan center, but it has caused the death of more than 1,000 trees in Baltimore. The loss in Gloucester, N. J., is estimated at 300 trees. A survey recently made by the New Jersey Department of Agriculture disclosed small centers of the disease in 20 other towns of southern New Jersey. Sixteen of these are within 5 miles of the long-standing center in Gloucester. No other intentional survey of municipalities has been made, but the occurrence of the disease has been confirmed in the following places: Village of Great Kills, Staten Island, N. Y.; Newark, N. J.; Claymont, Wilmington, and Elsmere, Del.; Pittsburgh, Gettysburg,

FIGURE 1.—View on Rosalind Avenue, Gloucester, N. J., showing in the row on the left the destructive effects of canker stain on London plane. The disease has killed six trees, of which three have been beheaded and three have been removed; two others are infected in both crown and trunk.

Greensburg, Chester, Tyrone, Boothwyn, and Chadds Ford, Pa.; Baltimore, Md.; Washington, D. C.; Williamsburg, Portsmouth, and Altavista, Va.; Petersburg and vicinity, Vulcan, and South Charleston, W. Va.; Middlesboro and Burgin, Ky.; Magnolia, N. C.; Kingsport and Knoxville, Tenn.; Vicksburg, Miss.; St. Louis, Mo.; and Cleveland, Ohio.

Description

Canker stain may occur in either branches or trunks. Dark-brown or black discoloration, usually in lens-shaped or more elongated areas in line with the grain of the underlying wood, is the first external symptom on smooth, cream, yellow, or green bark areas from which the old plates and scales have recently exfoliated. On bark areas retaining the old plates and scales the first noticeable symptom is an elongate



depression or furrow beneath which the inner bark is blackened and dead.

During the first year of infection most cankers are not sufficiently noticeable to attract the attention of any except specialists on tree diseases. During this period they commonly do not become more than 2 inches wide, but they may be 20 to 40 inches long. The cankers widen each year (fig. 2), often rather irregularly; separate cankers coalesce, finally girdling the stem and resulting in the death of the portions of the tree beyond them. Branch cankers may eventually reach the trunk and girdle it. Aging cankers usually appear to be blackened in contrast with the bark surface of adjacent living portions of the tree (fig. 3). The dead bark darkens, dries, cracks, and falls away, exposing the wood surface, which dries, checks, and collects soot. Experience thus far indicates that once the trunk of a London plane is infected the tree is doomed, but a single infection may require 3 to 5 years to kill a clear stem 1 foot in diameter.

The reddish-brown or bluish-black discoloration of the infected wood is the most distinctive symptom of canker stain. The stain is most intense in the medullary rays. In cross sections this discoloration usually appears in sectors delimited roughly by medullary rays (fig. 4). It is practically coextensive with the area invaded by the parasite. In one growing season the fungus usually advances about 3 inches radially; but the rate of progress around the trunk is less, and progress in the longitudinal direction

FIGURE 2.—A canker about 3 years old showing (*a*) the point of inoculation and (*b*) the annual zonation of the canker photographed January 1944. The wound at which this infection started evidently was made in late September or October 1940, probably by a stone thrown by a boy.

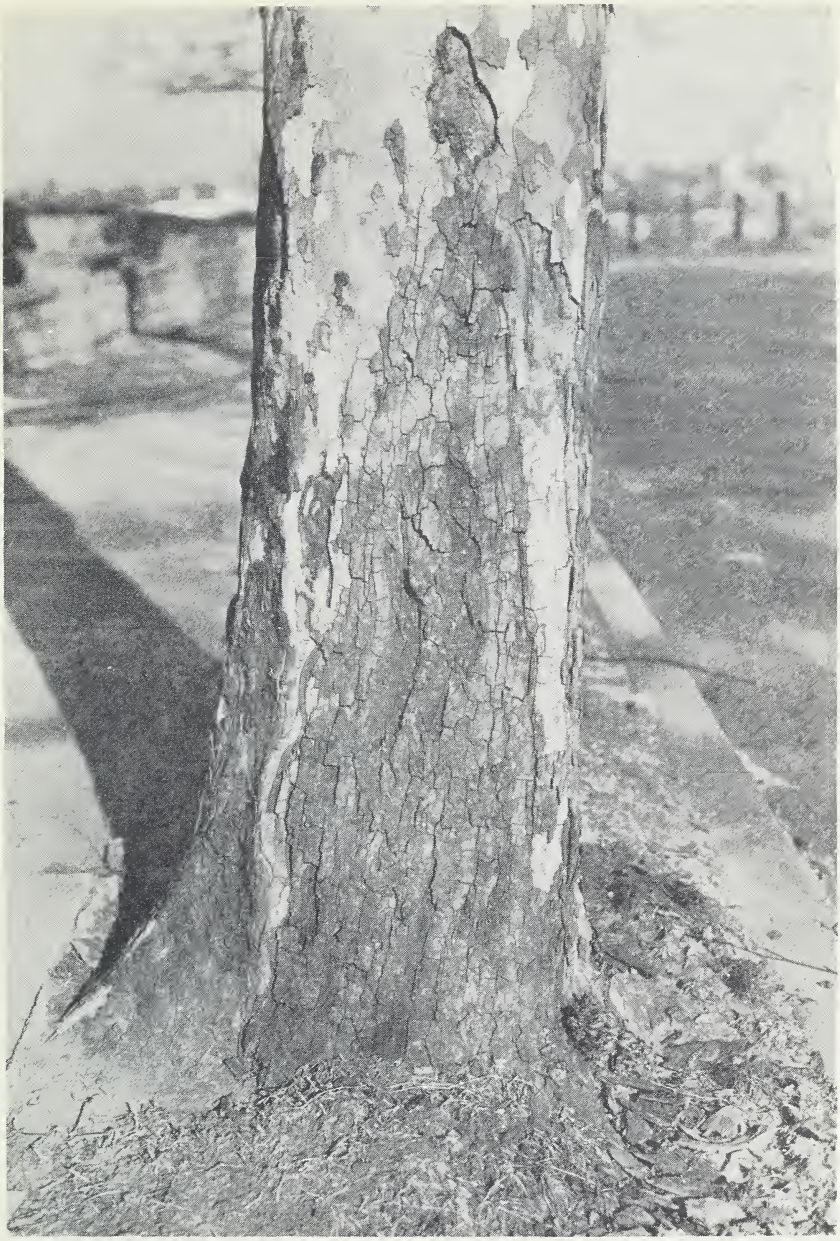


FIGURE 3.—A large, aging canker, showing the typical blackening, peeling, and checking.

(p. 4) may be much more. Observations of discoloration patterns indicate that the special ability of the fungus to grow in the rays allows it to produce secondary cankers; these are formed by the fungus proceeding outward at any angle from the original infection line after the pith has been invaded. The cambium is killed wherever the fungus contacts it.

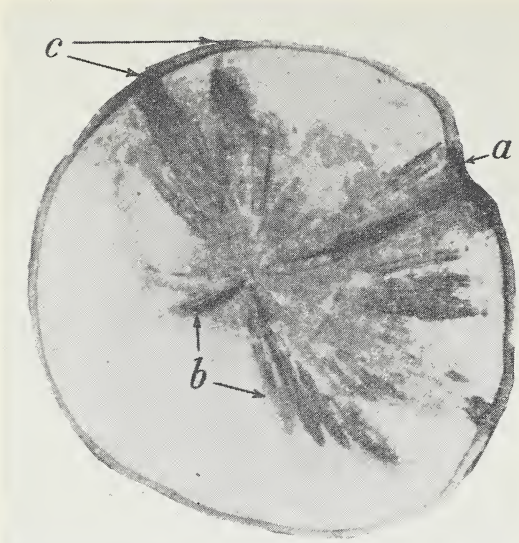


FIGURE 4.—Cross section of an infected stem, showing the discoloration characteristic of canker stain. Note (*a*) the depression coincident with the original line of infection, (*b*) the flaring of the infection in radial lines from the pith, and (*c*) the darkening of the bark at points where the discoloration has reached the cambium.

Leaves of affected trees usually do not show signs of injury until the cambium is dead around almost the entire circumference of an infected stem. As a rule, the first leaf symptoms are dwarfing and yellowing. In most trees having the infection in the trunk the disease has advanced so far by the time the first effects become obvious in the foliage that the trees may be expected to die during the following year. Progression to a condition of wilting and defoliation may be rapid in some cases. On small trees and on branches less than 5 inches in diameter, the normal green leaves may wither suddenly after having developed to full size during the first half of the summer.

Hosts

At present canker stain is a major problem on cultivated planetrees only. Most of these are the London plane. Many people in this country call this the Oriental plane, but the latter species (*Platanus orientalis* L.) is rare even in botanical gardens. London plane is considered a hybrid between *P. orientalis* and *P. occidentalis* L. In the beginning it was probably a single type regularly propagated by cuttings. Several forms or types of planetrees intermediate between the two parental species may now be seen along city streets. Some of these forms may have arisen as seedling segregates from the imported hybrid; others may represent the backcross of the hybrid to *P. occidentalis*. London plane is now described in Bailey's Standard Cyclopedia of Horticulture as "sometimes resembling more the one and sometimes more the other parent."

Canker stain also attacks native sycamore, or buttonball, (*Platanus occidentalis*) and is known to have decimated the rows of it along the streets of Magnolia, N. C.; but in general, native sycamore seems to be less susceptible than London plane. The disease occurs infrequently in native stands of *P. occidentalis* in some localities where man seldom could have come in contact with the host trees. Surveys made along

the streams in Chester County, Pa., and in the Petersburg-Elkins district of West Virginia disclosed that 0.5 percent of the sycamores in both localities are infected. This very likely means that the parasite is indigenous to North America, but it has not been recognized as the cause of important losses among forest trees.

Platanus occidentalis is widely distributed in the eastern half of the United States, where it is found most abundant along streams. Many specimens attain great size and beauty, and the wood is valued for special uses such as butcher's blocks, interior trim, furniture, and packages for food and tobacco. As a shade tree the species is of more importance than has been generally recognized. It is especially important in cities, towns, and rural areas of the Southeastern States.

A small-scale trial of *Platanus orientalis* seedlings in comparison with London planes of the same size, all inoculated in the same manner with the canker stain fungus, demonstrated the susceptibility of *P. orientalis* but gave no indication that it was more susceptible than London plane. The trees of *P. orientalis* used in this test were grown at Morristown, N. J., from seed collected in Athens, Greece, and Tiflis, Georgia, Union of Soviet Socialist Republics, by representatives of the Division of Plant Exploration and Introduction, Bureau of Plant Industry, Soils, and Agricultural Engineering.

Nothing is yet known about the susceptibility to canker stain of the several species of *Platanus* native to the Southwestern States and Mexico.

Cause

Canker stain is caused by a fungus of the genus *Endoconidiophora*. This fungus had not been recognized as a pathogen before the work of Jackson in 1935, and it has not yet been given a specific or varietal name. In morphological characteristics it closely resembles *E. fimbriata* (Ell. and Halst.) Davidson, the cause of black rot of sweetpotato; but in manner of growth in the wood it is much like the blue-staining fungi, some of which are species of the same genus.

Transmission

The canker stain fungus sporulates abundantly on recently killed or cut wood surfaces of infected planetrees during periods of high moisture from May until October. Three kinds of spores, all of which are infectious, are produced. Upon aging, much of the mycelium in the wood produces spores with thickened walls. These spores probably have better chances than the thin-walled ones for survival through periods of low moisture and against competition from other fungi.

Observations and experiments indicate that the fungus seldom, if ever, enters the planetree through undamaged bark. Under favorable moisture conditions, however, only the very slightest scratch in the waxy cuticle of the bark freshly exposed by exfoliation is needed to allow entry of the fungus. Observations of cankers less than 3 years old have in many cases disclosed the nature of the injuries through which the fungus entered. Transmission may be effected by any agency that comes in contact with the fungus on a diseased tree and then causes even a slight abrasion on a healthy tree or contacts a fresh injury. The trunks of street trees are particularly liable to injuries. Many of these are made by unappreciative adults, but most of them are made by boys in their

play. If a boy uses a jackknife or scout ax in the diseased area of one tree and then makes an injury with it in a healthy tree, the chances are much in favor of the latter tree becoming infected. Several instances of transmission clearly attributable to lawn mowers have been observed in rows of fine, large trees. In some cases injuries to branches by moving vans have obviously accounted for transmission of the fungus.

The longevity of the fungus on objects such as those mentioned has not been tested, but pruning saws were highly effective inoculating agencies on the twelfth day after contamination, the longest interval tried.

Field observations and carefully conducted experiments agree in indicating that the role of wind in disseminating the fungus is minor. It has been observed several times in solid plantings that all planetrees in one row for the distance of a block may be diseased or dead, whereas all those in the row across the street may remain free of infection for years. Experimental trials of wind dissemination, involving the exposure of numerous spores of the fungus in a nursery block where fresh injuries had been made on susceptible trees, gave only a few infections. The greatest distance of a resulting infection from the source of inoculum was only 25 feet. Spores are likely to have been carried that distance by wind-driven rain during a thunderstorm.

Little is known about the means of natural spread of canker stain. Most of the infections found on native sycamores in the Petersburg-Elkins district of West Virginia, which may be designated as the region of origin of the Potomac, James, and Tygart Rivers, are associated with wounds made by driftwood. At present birds and squirrels seem to be the most likely suspects as agents of spread, but there is no actual evidence against them. The fact that dissemination of the fungus in cities has not been more indiscriminate indicates that such creatures are not efficient carriers of the fungus. Further negative evidence on this point was obtained by leaving for 4 years several known cases of the disease in a plot where birds and squirrels were numerous but man was practically excluded. The site of the plot was an abandoned nursery in the Water Department grounds at Baltimore, Md., where the London planes had grown to 6 to 12 inches in diameter at breast height and to 25 to 35 feet in height. A number of the planetrees were used for inoculation experiments in 1939 and 1940, and 16 diseased trees were left well distributed among 78 recorded trees. At the end of 1940 the 62 noninoculated trees were known to be free of evidence of infection, although several of them were standing within 4 feet of cankered trees. In 1944 all of the trees were examined and not a single new canker was found. This appears to be strong evidence that natural agencies are not important in transmitting the canker stain fungus.

Pruning operations as ordinarily carried out are highly effective means of spreading the disease (fig. 5). Tests conducted over a period of 4 years have shown that infection develops in about 40 percent of the wounds made in the growing season with saws that have been used in diseased wood immediately beforehand. Tests of infection at rope burns were made with a contaminated climbing rope. About 50 percent of the burns made the day of contamination developed infection; 25 percent of those made the day after contamination became infected. Several cases of infections that started in wounds made by the pruner's shoes while climbing have been observed.

Contaminated asphalt wound dressing of the commonly used forms represents the most insidious and interesting means of transmission of

this destructive canker stain fungus. As handled by the practical arborist the wound-dressing container rapidly collects sawdust and fragments of bark and wood; much of this debris is carried into the container on the brush, because of the adhesive nature of the paint. Such material from saw cuts through diseased wood carries the fungus in abundance. Laboratory and field experiments have demonstrated that the fungus survives for long periods in many of the popular brands of asphalt paint and appears to be stimulated by some; in other brands, popular in certain localities, the fungus succumbs after 6 to 10 hours. During the summer 90 to 100 percent of the sterile wounds treated with several of the brands after they were contaminated with infected sawdust became infected. In parallel tests about 60 percent of the wounds painted during the day of contamination and with selected brands in which the fungus is known to succumb after a few hours became infected. This finding makes it clear that use of a paint in which the fungus can survive for even a few hours may result in extensive spread of the disease.

In the wintertime there is a period of 10 to 12 weeks in which no infection results from the use of contaminated pruning tools if the wounds are left unpainted. Repeated experiments in New Jersey have shown that no infection occurs when the fungus is applied to unprotected wounds, even fresh chisel incisions, between December 1 and February 15. Thus arborists in the northern half of the known range of canker stain have a readily applicable means of preventing transmission of the fungus, simply by arranging to do routine pruning of their planetrees during this period. It is not known whether the fungus is similarly impotent in the southern

FIGURE 5.—Two views of infections clearly attributable to transmission of the fungus in pruning operations. *A*, Cankered 2-inch branch infected at a scratch (*a–b*) made by a saw. There is no doubt that this injury was made accidentally by a pruner. *B*, Cankered main stem of a medium-sized tree. The infection clearly started in the left edge of the pruning cut. Note the poor development of the callus on the left side in contrast with the normal healing on the right. The fungus may have been introduced by either the pruning saw or the wound paint or by both.

half of the known range of the disease. However, 25 to 50 percent of the pruning wounds made with contaminated saws in wintertime and painted with selected brands of asphalt paints handled aseptically by use of individual sterile applicators became infected. Similar unpainted wounds did not become infected. These results evidently mean that the paint serves as protection against the effects of weathering until it is warm enough for the fungus to become active.

One observation of particular significance on the progress of this disease is that, even in areas where it has been most destructive, it has not attacked trees that have not been pruned or mutilated in any way. In general, such trees are inside good fences or are carefully watched. Another significant observation is that new centers commonly begin with trees at the ends of the rows or at street corners; in some new centers the first cankers are associated with wounds made in line-clearance pruning.

Control

As suggested by the statements on transmission, canker stain is one destructive tree disease that can be brought under economic control in relatively little time on any property having an interested person in charge or in any municipality having a commission for the care of shade trees. The distinctiveness of the symptoms is one very important factor in making this disease controllable. In 2 days any qualified arborist can learn to recognize the symptoms by examining diseased trees and comparing them with noninfected ones. The limited means of transmission and the safe period for pruning in the northern half of the disease range (December 1 to February 15) also favor practical control.

In the control of this disease sanitation is the first essential. The facts presented on transmission and the results obtained thus far in two residential and two park areas where sanitation has been undertaken point to the conclusion that sanitation is highly effective. Some trees having infections on branches only may be saved by carefully pruning off the affected parts. A clearance of 3 feet between the end of a branch canker nearest the trunk and the severing cut is usually necessary to remove all infected wood. The surgical work must be carefully done to avoid the inoculation of the tree at other points.

Disinfection of pruning tools is effective and feasible. Saws, hooks, knives, and chisels may be readily disinfected by dipping or thoroughly swabbing them in denatured alcohol of the type commonly used as antifreeze. The soles of the climber's boots and portions of ladders that come in contact with diseased trees may be disinfected by thoroughly swabbing with alcohol. Climbing ropes may be disinfected by exposure to formaldehyde vapor for 3 hours. The rope may be fumigated by exposure to fumes from 100 cubic centimeters, or approximately one-fourth of a pound, of commercial formaldehyde. The disinfectant should be spread over an area of approximately 100 square inches beneath a false bottom in a tightly capped container holding about 10 gallons. A test made by the National Bureau of Standards demonstrated that the breaking strength of ½-inch manila rope was not affected by six 3-hour exposures.

Formaldehyde vapor is irritating to the eyes, and poisonous. Care should be taken to avoid breathing the fumes.

Upon the discovery that the causal fungus is transmitted in asphalt wound dressing, it became obvious that an antiseptic, noninjurious dressing would be an important factor in bringing the disease under control. Efforts to formulate such a dressing have not been entirely successful, but it is now possible to recommend a mixture of 0.2-percent phenylmercury nitrate in paints of the gilsonite-varnish class.[3] The highly germicidal phenylmercury nitrate will prevent these paints from carrying the fungus (fig. 6). Tests show that this combination is not completely effective in preventing infection at wounds made with contaminated tools; therefore, the disinfection of pruning tools must be continued as a part of a control program until a truly antiseptic paint is available. Phenylmercury nitrate of this concentration should not be used with paints based on petroleum-residue asphalt of the roof-coating class or with those carrying pine oils and tars, because results indicate that these combinations may be too injurious to the cambium of the

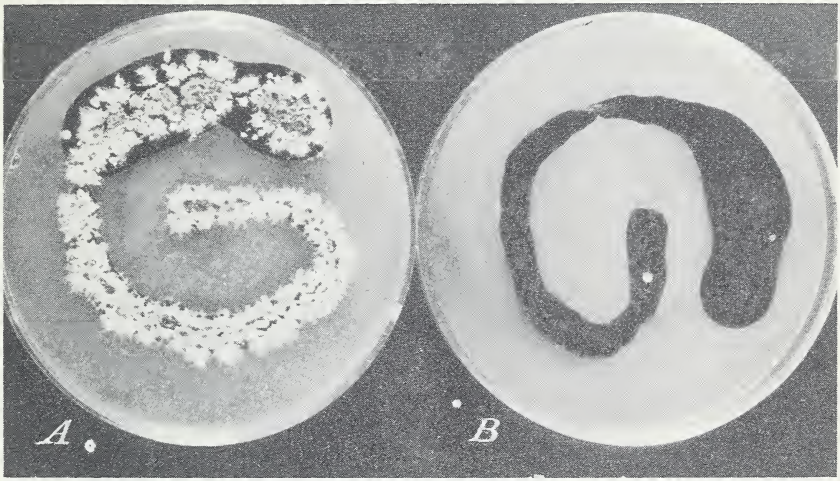


Figure 6.—Comparison of samples of a wound dressing of the gilsonite-varnish type with and without phenylmercury nitrate: *A*, Sample without phenylmercury nitrate, showing luxuriant growth of the canker stain fungus; *B*, sample containing 0.2 percent of phenylmercury nitrate and showing no growth.

planetree. It is necessary that the chemical be thoroughly mixed into the paint; as an aid in mixing, the finely powdered chemical may be first mulled in a small amount of linseed oil.

Phenylmercury nitrate is highly poisonous and must be handled with caution. Neither of two workers who have handled numerous experimental mixtures of this chemical in the laboratory at Morristown, N. J., during the past 4 years has suffered ill effects. In lower concentrations this and other phenylmercury salts have been used in cosmetics for several years. However, individuals differ in sensitivity to mercurials. **Therefore anyone using paint fortified with phenylmercury nitrate would be well advised to stop at once and wipe away all spots that make contact with his skin.**

[3] The paint should be of Federal specification TT–V–51. A copy of this specification can be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for 5 cents.

Recommended Practices

For districts where canker stain is established the control recommendations are summarized as follows:

1. Remove all diseased planetrees or parts of them to eliminate sources from which the causal fungus may be spread to unaffected trees.
2. Avoid all unnecessary mutilation of planetrees.
3. In the latitudes of Philadelphia and New York, prune planetrees between December 1 and February 15 if possible. Do not use asphalt paint on wounds made during this period.
4. Disinfect all pruning tools before use on healthy planetrees between February 16 and November 30. Denatured alcohol such as used for antifreeze is a satisfactory disinfectant when used as a dip or swab.
5. Use every possible precaution to prevent contamination of climbing ropes. They may be disinfected, however, by exposure to formaldehyde vapor for 3 hours.
6. If a wound dressing is necessary, use a paint of the gilsonite-varnish type into which 0.2 percent phenylmercury nitrate has been mixed. The phenylmercury nitrate makes the paint unable to carry the fungus.

For districts where the disease is not established planetrees can be protected by observing just three precautions.

1. Disinfect all pruning equipment thoroughly before the work begins.
2. Use new paint and new brushes and other painting equipment.
3. If new painting equipment is not available, use a paint of the gilsonite-varnish type containing 0.2 percent of phenylmercury nitrate.

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